



SPACE-BASED POSITIONING
NAVIGATION & TIMING
NATIONAL COORDINATION OFFICE

Status of GPS: Constellation Modernization and U.S. Diplomatic Activities

**Maureen Walker
Senior State Department Representative**

**2009 Regional Workshop
Mexico – November 16, 2009**



Overview



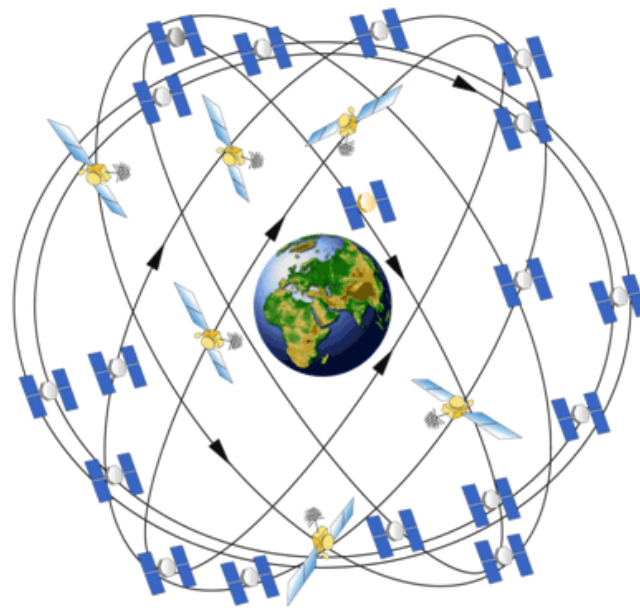
- **The Global Positioning System**
- **U.S. Space-Based Positioning, Navigation and Timing (PNT) Policy**
- **International Cooperation**



The Global Positioning System



- **Baseline 24 satellite constellation in medium earth orbit**
- **Global coverage, 24 hours a day, all weather conditions**
- **Satellites broadcast precise time and orbit information on L-band radio frequencies**
- **Two types of service:**
 - Standard (free of direct user fees)
 - Precise (U.S. and Allied military)
- **Three segments:**
 - Space
 - Ground control
 - User equipment





GPS is a Critical Component of the Global Information Infrastructure



Satellite Operations



Precision Agriculture



Surveying & Mapping



Aviation



Communications



Disease Control



Power Grids



Trucking & Shipping



Oil Exploration



Fishing & Boating



Personal Navigation



Civil GNSS Applications



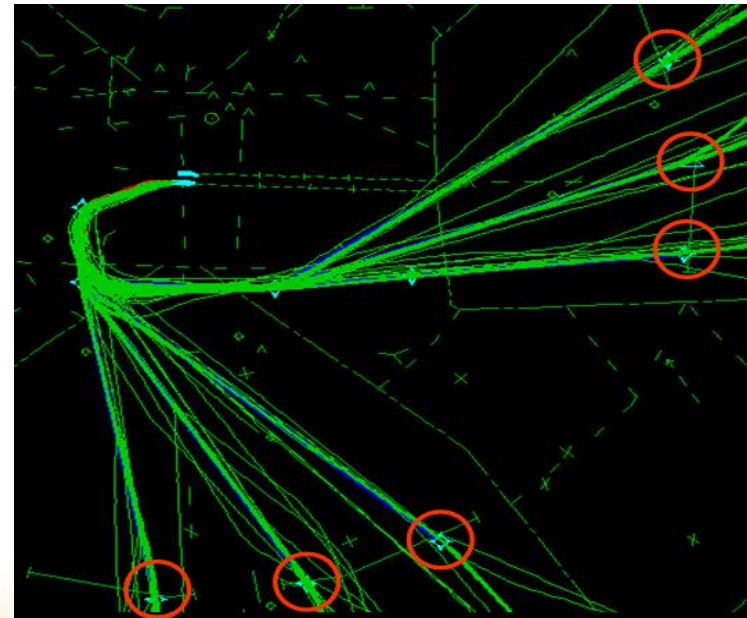
- **Enabling technology**
 - New applications emerging every day
 - \$68 Billion industry worldwide by year 2010
- **Wide use in transportation safety**
 - Aviation, maritime, railroad, highway, etc.
 - Potential to reduce land-based navigation systems
 - Centerpiece of future transportation infrastructure
- **Wide range of civil uses**
 - Telecommunications, surveying, law enforcement, emergency response, agriculture, mining, etc.
 - Used in conjunction with remote sensing



Aviation



- **Reliable and accurate positioning worldwide**
- **Reduced delays**
- **More fuel-efficient routes**
- **Increased system capacity with enhanced safety**





Maritime



- Large ships, fishing & recreation boats
- Harbor entrance and approach
 - Regardless of visibility
- Hydrographic Survey
- Buoy Positioning, etc.





Railroads



- **Enhances safety**
 - Reduces accidents
- **Increases capacity and efficiency**
 - Closer train spacing reduces investments
 - Reduces fuel consumption
- **Rapid rail structure and condition mapping**
 - Improves maintenance capability
- **Increased efficiency and capacity through positive train control**
 - Tracking location of vehicles/containers
 - Rapid rail structure and conditioning mapping





GNSS Applications – Improving Highway Operations



Vehicle Infrastructure Integration (VII)

- Improving safety and reducing congestion will require more efficient management of the roadway system
- Vehicle-highway information exchange is key to improved management and operation of the transportation network
 - Provide information on traffic conditions, crashes, adverse weather and road conditions, etc.





GNSS Applications – Automatic Vehicle Location



- **Cargo Fleet Tracking**
 - Improves safety and security
- **Fleet Control/Dispatch**
 - Increases fuel savings
 - Improves asset management
- **Emergency Operations**
 - Reduces response times
 - Reduces injury and property loss
- **Road Maintenance**
- **In Vehicle Navigation**
 - Determines accurate position
 - Reduces air pollution

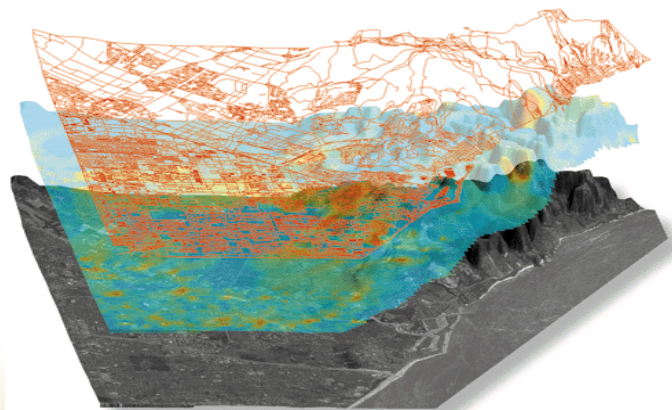


Kim Loeb Collection





Surveying/Mapping/GIS



- **Sub-centimeter accuracy**
- **100%-300% savings in time, cost, labor**
- **Most major development projects require surveying**
 - Rural electrification
 - Telecom tower placement
 - Pipeline installation
 - Dam construction
- **Port dredging operations**
- **Oil, gas, and mineral exploration**
- **Flood plain mapping**



Precision Agriculture



- **Maximize use of resources**
 - Optimize plowing of crop rows
 - Tailor applications of seeds, fertilizer, water, pesticides
 - Improve management of land, machinery, personnel, time
 - Greater crop yields
 - Net benefit: \$5-14 per acre
- **Minimize environmental impacts**
 - Localize identification and treatment of distressed crops that reduces chemical use
 - Precisely level fields to prevent fluid runoff





Environmental Protection



- **Forest protection**
 - Logging enforcement (e.g., Mato Grosso)
 - Firefighting
 - IBAMA: 230 GPS units
- **Fishing boundary enforcement**
- **Endangered species and habitat preservation**
- **Natural resource management**
- **Hazardous cleanup**
 - Oil spills, toxic waste
- **Atmospheric modeling**

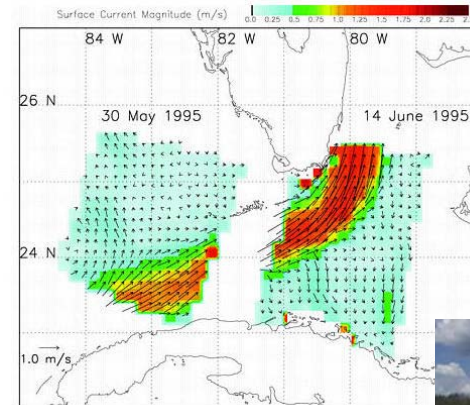




Scientific Research



- **Monitoring geological change**
 - Glaciers, tectonic plates, earthquakes, volcanoes
- **Wildlife behavior**
- **Atmospheric modeling**
 - Water vapor content
- **Oceanic studies**
 - Tidal patterns
 - Surface mapping
- **Time transfer**
- **Space Exploration**

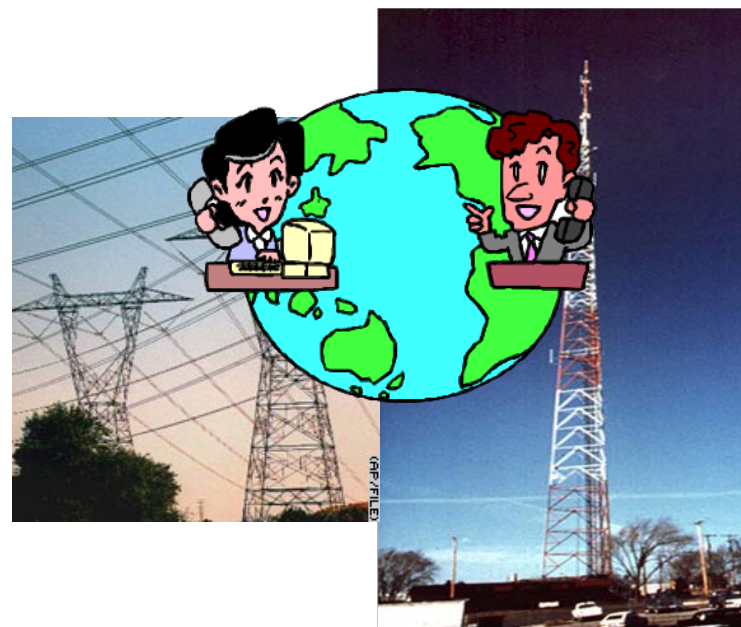




Timing



- GPS offers an inexpensive alternative to costly, high maintenance timing equipment
- Telecommunications network synchronization & management
 - Phones, pagers, wireless systems
 - LANs, WANs, Internet
- Financial transactions, e-commerce
- Electrical power grid management & fault location

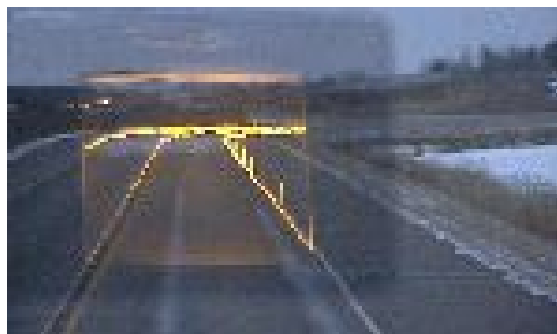




New Applications Emerging Every Day



- Wireless/mobile applications
- Child/pet tracking
- Spacecraft control
- Power grid management
- Open pit mining
- Automatic snowplow guidance



GPS Antennae



Keys to the Global Success of GPS



- **Program Stability and Performance**
- **Policy Stability and Transparency**
- **Private Sector Entrepreneurship and Investment**



GPS Constellation Status



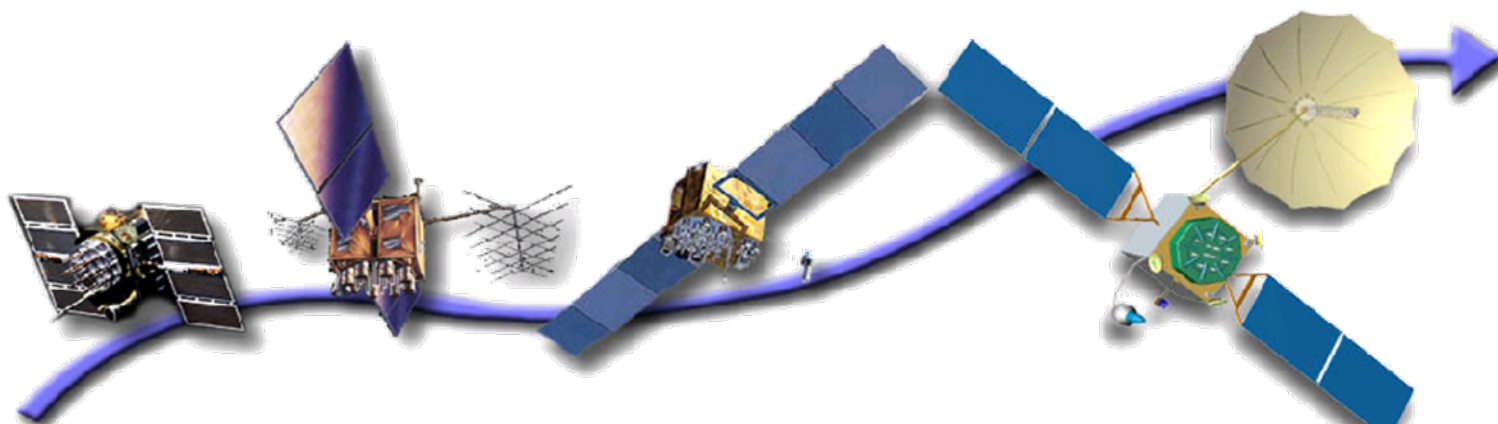
30 Operational Satellites (Baseline Constellation: 24)

- **11 Block IIA satellites operational**
- **12 Block IIR satellites operational**
- **7 Block IIR-M satellites operational**
 - Transmitting new second civil signal (L2C codeless)
 - IIR-20(M) only transmitting new civil signal (L5 codeless)
- **U.S. Government continuously assessing constellation health to determine launch need**
 - Newest IIR-M satellites launched
 - IIR-20 (M) 24 March 2009
 - IIR-21 (M) 17 August 2009
 - Next launch: IIF ~ June 2010
- **Global GPS civil service performance commitment met continuously since 1993**





GPS Modernization Program



Increasing System Capabilities ♦ Increasing Defense / Civil Benefit

Block IIA/IIR

Basic GPS

- Standard Service
 - Single frequency (L1)
 - Coarse acquisition (C/A) code navigation
- Precise Service
 - Y-Code (L1Y & L2Y)
 - Y-Code navigation

Block IIR-M, IIF

IIR-M: IIA/IIR capabilities plus

- 2nd civil signal (L2C)
- M-Code (L1M & L2M)

IIF: IIR-M capability plus

- 3rd civil signal (L5)
- Anti-jam flex power

Block III

- Backward compatibility
- 4th civil signal (L1C)
- Increased accuracy
- Increased anti-jam power
- Assured availability
- Navigation surety
- Controlled integrity
- Increased security
- System survivability



GPS Block IIR/IIR-M Status



- **21 satellite procurement: 13 IIRs, 8 IIR-Ms**
- **12 IIRs operational: 1st launch, 22 July 1997**
- **7 IIR-Ms operational: 1st IIR-M launch, 25 September 2005**
 - Includes M-Code capability
 - Broadcasting new civil signal (L2C)
 - without Nav Message
 - Help provide improved accuracy
 - for civil users with second signal
 - IIR-20(M) is broadcasting an L-5 demo signal





GPS Block IIF Status & Capabilities



- **Phased satellite procurement**
 - Increases number of satellites broadcasting L2C
 - Increases number of satellites broadcasting M-code
 - Adds third civil signal - L-5
 - Flex power for signal assurance
- **First IIF launch is planned for June 2010**





GPS Block III Satellite Capabilities



- **Completes population of L2C and L5 capable GPS constellation**
- **Provides operational capability for L2C and L5**
 - In combination with GPS IIR-M and IIF satellites
- **4th Civil Signal – L1C**
- **L1C is interoperable with Galileo and Quasi-Zenith Satellite System**
- **Increased anti-jam capability, security, accuracy**
- **System survivability**
- **Navigation surety**
- **First GPS III launch is planned for approximately 2014**



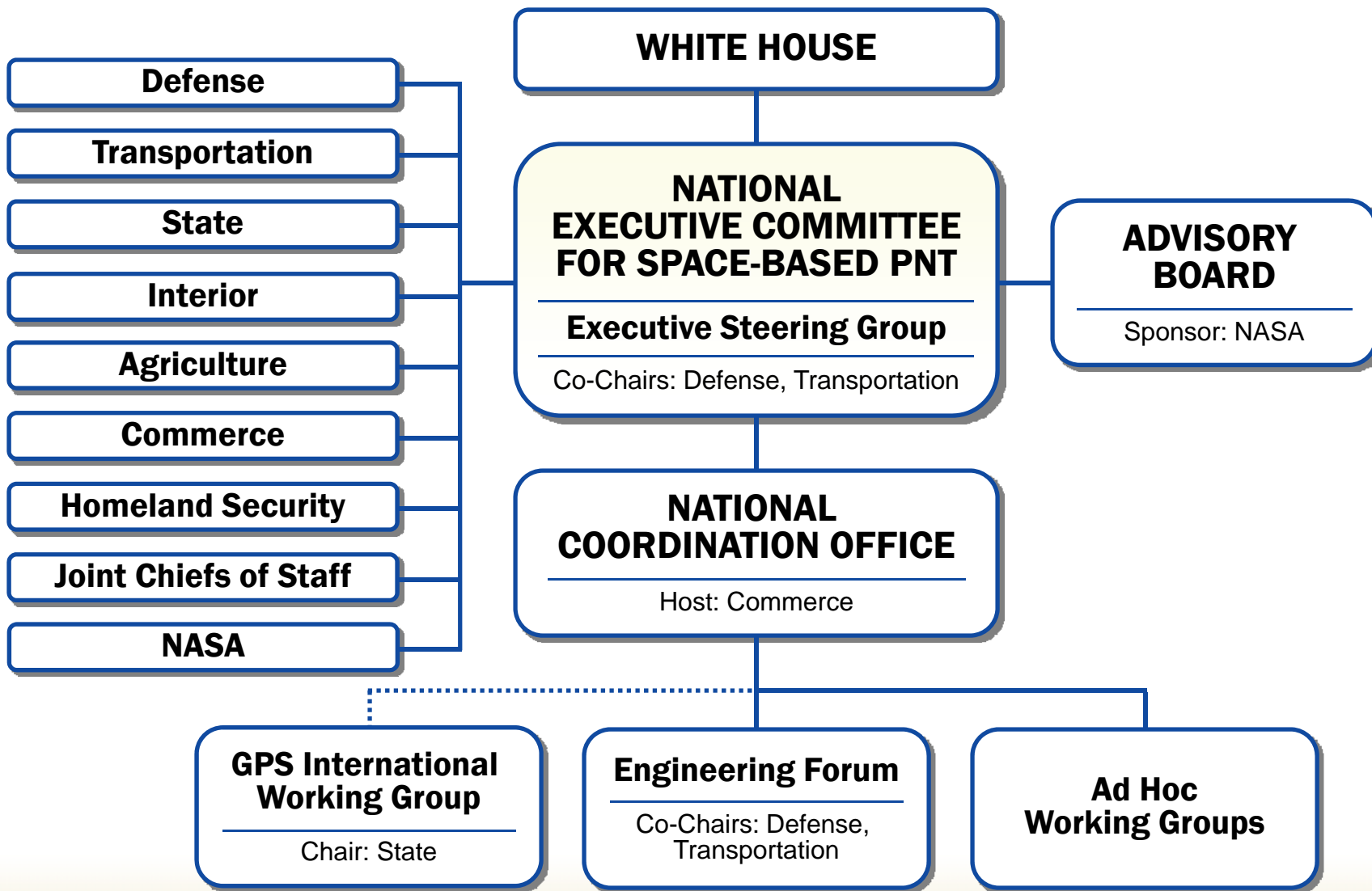
U.S. Policy Promotes Global Use of GPS Technology



- **No direct user fees for civil GPS services**
 - Provided on a continuous, worldwide basis
- **Open, public signal structures for all civil services**
 - Promotes equal access for user equipment manufacturing, applications development, and value-added services
 - Encourages open, market-driven competition
- **Global compatibility and interoperability with GPS**
- **Service improvements for civil, commercial, and scientific users worldwide**
- **Protection of radionavigation spectrum from disruption and interference**



U.S. Space-Based PNT Organization Structure





U.S. Space-Based PNT Policy

(Excerpts focused on International Relations)



Goals:

- U.S. space-based PNT systems and services remain essential components of internationally accepted PNT services
- Promote U.S. technological leadership in applications involving space-based PNT services

To achieve this, the United States Government shall:

- Encourage foreign development of PNT services/systems based on GPS
 - Seek to ensure foreign space-based PNT systems are interoperable with civil GPS and augmentations
 - At a minimum, ensure compatibility

The Secretary of State shall:

- Promote the use of civil aspects of GPS and its augmentation services and standards with foreign governments and other international organizations
- Lead negotiations with foreign governments and international organizations regarding civil PNT matters



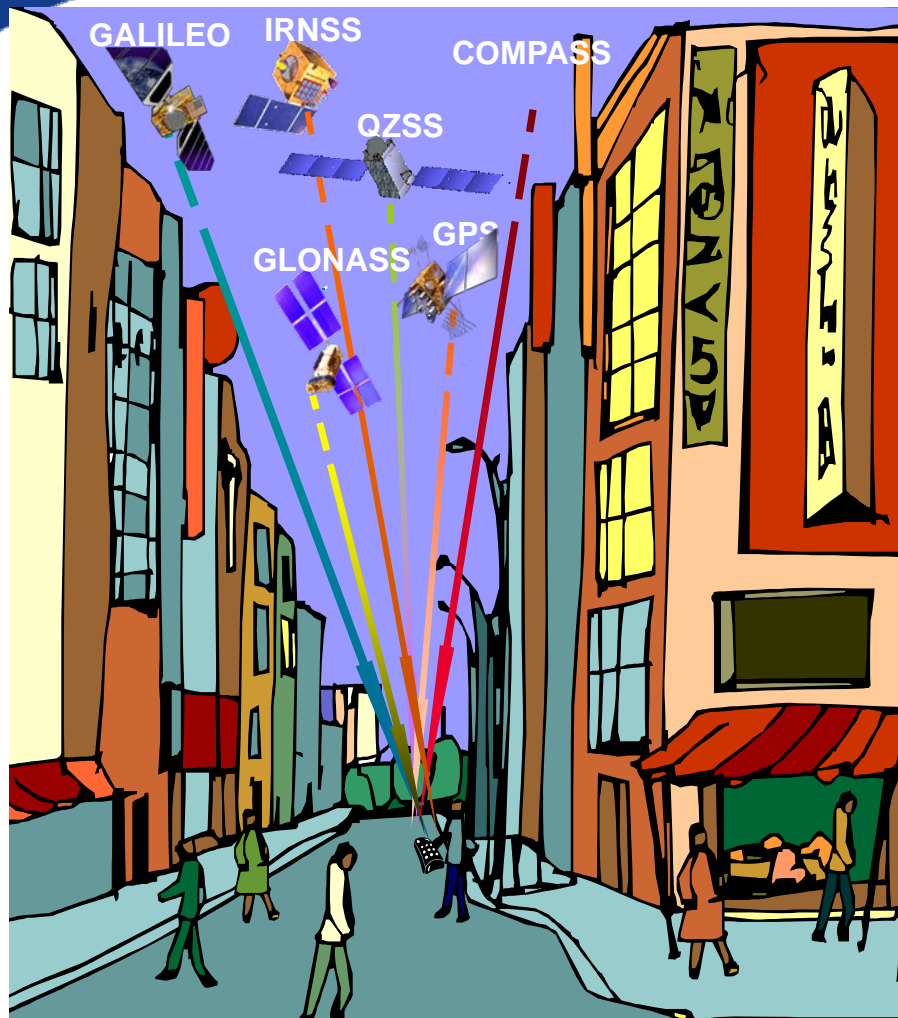
U.S. Objectives in Working with Other GNSS Service Providers



- **Ensure compatibility — ability of U.S. and non-U.S. space-based PNT services to be used separately or together without interfering with each individual service or signal**
 - Radio frequency compatibility
 - Spectral separation between M-code and other signals
- **Achieve interoperability — ability of civil U.S. and non-U.S. space-based PNT services to be used together to provide the user better capabilities than would be achieved by relying solely on one service or signal**
 - Primary focus on the common L1C and L5 signals
- **Promote a level playing field in the global marketplace**

U.S. pursuing through public sector cooperation, both bilateral and multilateral

The Goal of RNSS Civil Interoperability



- Ideal interoperability allows navigation with one signal each from four or more systems with no additional receiver cost or complexity

Interoperable = Better Together Than Separate

International Cooperation Venues



- **Bilateral**

- Europe
- Russia
- Japan
- India
- Others

- **Multilateral**

- International Committee on GNSS (ICG)
- Asia Pacific Economic Cooperation (APEC)
- ICAO, IMO, and ITU





U.S.–Europe Cooperation



- **GPS-Galileo cooperation agreement signed in 2004**
- **Four working groups established:**
 - **Compatibility/Interoperability**
 - **Trade**
 - **Next-Generation GNSS**
 - **Security**
- **Improved civil signal (“MBOC”) jointly adopted in 2007**
- **Plenary meeting held Oct 2008**





Additional Bilateral Cooperation



- **U.S.-Japan Joint Statement on GPS Cooperation in 1998**
 - Japan's Quasi Zenith Satellite System (QZSS) designed to be fully compatible and highly interoperable with GPS
 - Bilateral agreements to set up QZSS monitoring stations in Hawaii and Guam – Guam station completed
- **U.S.-Russia Joint Statement issued in Dec. 2004**
 - Negotiations for a U.S.-Russia Agreement on satellite navigation cooperation underway since late 2005
 - Working Groups on compatibility/interoperability, search and rescue
- **U.S.-India Joint Statement on GNSS Coop. in 2007**
 - Technical Meetings focused on GPS-India Regional Navigation Satellite System (IRNSS) compatibility and interoperability held in 2008 and 2009



International Committee on Global Navigation Satellite Systems (ICG)



- **Emerg**ed from 3rd UN Conference on the Exploration and Peaceful Uses of Outer Space July 1999
 - Promote the use of GNSS and its integration into infrastructures, particularly in developing countries
 - Encourage compatibility and interoperability among global and regional systems
- **Members include:**
 - GNSS Providers (U.S., EU, Russia, China, India, Japan)
 - Other Member States of the United Nations
 - International organizations/associations



ICG International Committee on
Global Navigation Satellite Systems



International Committee on Global Navigation Satellite Systems (ICG)



- **2005: Establishment of ICG, UN Office Vienna, Austria**
 - **ICG Membership**
 - **GNSS Providers: United States, Russian Federation, European Commission, China, India, Japan**
 - **Other States Members of the United Nations (3)**
 - **International Organizations/Associations (14)**
- **2006: First Meeting of ICG, Vienna, Austria**
 - **Work plan:**
 - **WG A: Compatibility and Interoperability (USA and Russian Federation)**
 - **WG B: Enhancement of performance of GNSS services (India and ESA)**
 - **WG C: Information dissemination and capacity building (UN OOSA)**
 - **WG D: Interaction with international organizations, national and regional authorities (IAG, IGS, FIG)**



International Committee on Global Navigation Satellite Systems (ICG)



- **2007: Second Meeting of ICG, ISRO, Bangalore, India**
 - Within ICG is the Providers' Forum, consisting of those countries operating GNSS systems or with plans to develop one
 - Providers' Forum provides a venue for coordination and cooperation to improve overall service provision
- **2008: Third Meeting of ICG, JPL, Pasadena, USA**
 - Providers' Forum
 - Focused discussions on compatibility and interoperability
 - Exchange detailed information on systems/service provision plans
 - Exchange views on ICG work plan and activities
 - UN-affiliated Regional Centres for Space Science and Technology Education will act as the ICG Information Centres
 - Task Forces on Geodetic and Time References



International Committee on Global Navigation Satellite Systems (ICG)



- **2009: Fourth Meeting of ICG, St. Petersburg, Russia**
 - Further development of the ICG and Providers Forum work plans:
 - Further elaboration and implementation of compatibility and interoperability;
 - Monitoring of the ionosphere during the next solar maximum and its effects on GNSS receivers;
 - Adopted new principle on transparency: Every provider should publish documentation that describes signal and system information, policies of provision and minimum levels of performance for its open services;
 - Task Forces to align and maintain geodetic and timing references to enhance interoperability for the user
- **2010: Fifth Meeting of ICG will be jointly hosted by Italy and European Commission, October 18 – 22, Turin, Italy**



ICG Executive Secretariat

- UN OOSA is the ICG Executive Secretariat
- ICG provides:
 - Web-based information
 - Information brochures
 - Training/technical workshops for capacity building in developing countries
 - Promoting the use of GNSS technologies as tools for scientific applications



<http://www.icgsecretariat.org>



APEC GIT Cooperation



- **The Asia-Pacific Economic Cooperation (APEC) forum facilitates economic growth, cooperation, trade and investment in the Asia-Pacific region for its 21 member economies**
- **The APEC GNSS Implementation Team (GIT) has focused on air traffic control and aviation issues**
 - **The group has broadened its focus to the application of GNSS in all transportation sectors**
 - **Additional participation of GNSS government and industry experts at APEC GIT-13 at Singapore in July 2009; project proposal made on surface transportation**
 - **APEC GIT-14 meeting will be held in Seattle, Washington state, U.S.A., June 21-24, 2010**



Summary



- **GPS is highly dependable and its performance continues to improve**
- **U.S. policy encourages worldwide use of civil GPS and augmentations**
- **Policy stability and transparency improve industry confidence and investment**
- **International cooperation is a U.S. priority**
- **As new systems emerge globally, public sector cooperation is the key to success for all**



For Additional Information...



Global Positioning System

http://www.gps.gov/spanish.html

English | Español | Français | 普通话 | العربية

SISTEMA DE POSICIONAMIENTO GLOBAL

Al Servicio del Mundo

El Sistema de Posicionamiento Global (SPG) es un sistema de radionavegación de los Estados Unidos de América, basado en el espacio, que proporciona servicios fiables de posicionamiento, navegación, y cronometría gratuita e ininterrumpidamente a usuarios civiles en todo el mundo. A todo el que cuente con un receptor del SPG, el sistema le proporcionará su localización y la hora exacta en cualesquiera condiciones atmosféricas, de día o de noche, en cualquier lugar del mundo y sin límite al número de usuarios simultáneos.

El SPG se compone de tres elementos: los satélites en órbita, las estaciones terrestres de

INFORMACIÓN SOBRE EL SISTEMA

El Sistema de Posicionamiento Global

Ampliaciones al SPG

APLICACIONES

Cronometría

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http://pnt.gov/

SPACE-BASED POSITIONING NAVIGATION & TIMING

NATIONAL EXECUTIVE COMMITTEE

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The National Executive Committee for Space-Based Positioning, Navigation, and Timing (PNT) is a U.S. Government organization established by **Presidential directive** to advise and coordinate federal departments and agencies on matters concerning the **Global Positioning System (GPS)** and related systems.

The National Executive Committee is chaired jointly by the Deputy Secretaries of Defense and Transportation. Its **membership** includes equivalent-level officials from the Departments of State, the Interior, Agriculture, Commerce, and Homeland Security, as well as the Joint Chiefs of Staff and NASA. Components of the Executive Office of the President participate as observers to the National Executive Committee, and the FCC Chairman participates as a liaison.

A National Coordination Office located in Washington, D.C., provides day-to-day staff support to the National Executive Committee. It consists of an interagency staff headed by Director Michael Shaw. The National Coordination Office is a point of contact for inquiries regarding PNT policy.

An Advisory Board provides independent advice to the National Executive Committee through its sponsor agency, NASA.

Several working groups support the National Executive Committee through staff-level, interagency collaboration on

Get GPS status info and other user support at the [Navigation Center](#)

Learn more about the uses of space-based PNT at www.GPS.gov

What's New...

- Press Release
- Presentations and Reports from ICG-3
- New Web Section: Congressional Legislation**
- New Web Page: U.S. Policy Overview**
- Update: Frequently Asked Questions**
- Biennial GPS Report to Congress**
- New Web Section: Major Documents
- Presentation from Berlin GNSS Symposium**
- Presentations from GGSIC Tokyo**
- Joint Announcement on U.S.-Japan GPS Cooperation**
- Fact Sheet on Growth of WAAS Runway Approaches**

PNT.gov



**SPACE-BASED POSITIONING
NAVIGATION & TIMING**

NATIONAL COORDINATION OFFICE

**6822 Herbert C. Hoover Building
14th & Constitution Ave., NW
Washington, D.C. 20230**

Tel: +1 (202) 482-5809

Email: PNT.office@PNT.gov